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A New IGCC Program Strategy to Meet Future Energy Market Requirements

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Abstract

Changing market conditions, resulting from utility deregulation, more restrictive environmental regulations, and potential global climate change legislation, have generated significant concerns about the future of the U.S. utility and energy sectors. This change has caused DOE to rethink and refocus its strategy in the IGCC program from one of the strictly electric power generation to the production of market-based energy and chemical products while continuing to improve environmental performance.

The IGCC Product Team views its mission as fostering the commercialization of **gasification-based technologies** that convert carbon-based feedstocks into a suite of energy products including electricity, steam, hydrogen, fuels, and chemicals. This mission will be accomplished through the implementation of a strategic time-phased RD&D program in partnership with Government laboratories, academia, nonprofit institutions, and private industry and by close collaboration with other Product Teams.

To accomplish the mission, considerable effort was devoted to developing a comprehensive strategy that incorporated both the goals and objectives of DOE, and in particular those of Vision 21, as well as input from various customers and stakeholders. The RD&D component of the new program consists of the following:

- **Gasification:** Develop advanced gasification technologies to reduce capital and O&M costs, improve reliability and performance, and process a variety of alternative feedstocks.
- **Gas Cleaning and Conditioning:** Develop advanced processes for removing particulates and other contaminants from the raw gasifier product to: a) achieve near-zero discharge of pollutants (e.g., SO_x , NO_x , HAPs, particulates) at costs that are lower than today's technologies, and b) prepare the raw gasifier product for the stringent requirements of advanced power cycles and synthesis gas conversion processes.
- **Gas Separation:** Develop advanced technologies for the production of low-cost oxygen, separation of hydrogen from high temperature, high pressure synthesis gas, and the concentration of CO_2 for sequestration.
- **Products/By-product Utilization:** Improve the utilization of process and waste streams to generate value-added marketable products and to address integration issues with downstream synthesis gas utilization.

All of the above areas will be supported with comprehensive system and engineering analyses to establish performance targets and to develop optimized process configurations leading to the lowest cost commercial process.

The presentation will focus on the above areas. Implementation of the program strategy will occur during Fiscal Years 1998 and 1999, leading ultimately to a diversified portfolio of technologies and to a market-based program. An overview of potential future solicitations will be provided.

Integrated Gasification Combined Cycle

Gary J. Stiegel
Product Manager



IGCC 5/98

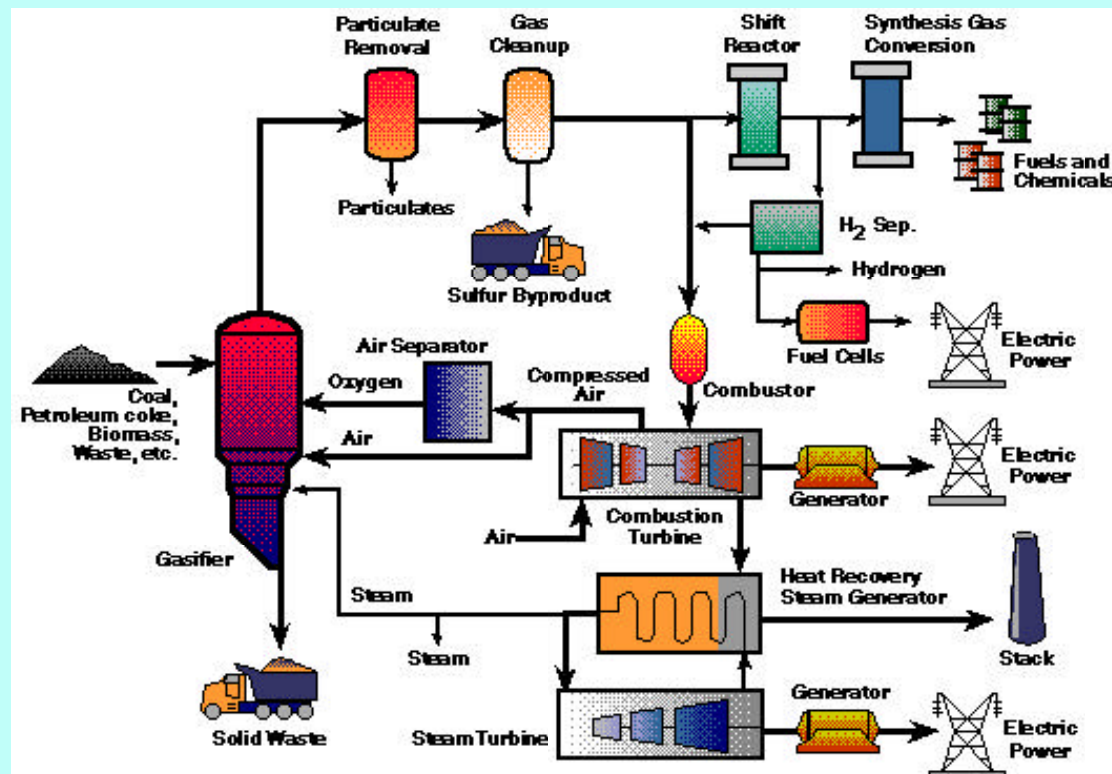


***Clean and
Affordable Energy
for the Future***



Integrated Gasification Combined Cycle

Technology Options



IGCC Product Benefits

■ Provides technology options to meet market requirements

- Baseload power generation (greenfield and repowering)
- Feedstock flexible (coal, biomass, petroleum coke, municipal waste, etc.)
- Product flexible (coproduction of power along with fuels, chemicals, hydrogen)

■ Environmentally superior

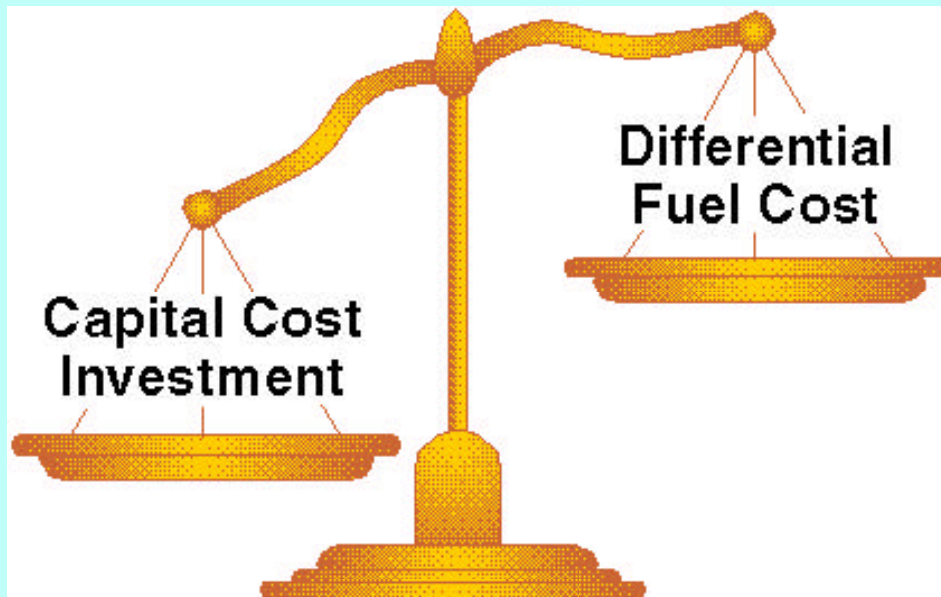
- Reduced emissions of SO_2 and NO_x (approaching NGCC)
- High thermal efficiencies leading to reduced CO_2 production
- Amenable to CO_2 sequestration
- Effective means of converting hazardous waste materials into valuable, benign products

■ Ease of converting NGCC facilities to coal-based systems

■ Efficiently utilizes our nation's domestic strategic resources

Coal-Based IGCC Decision Balance

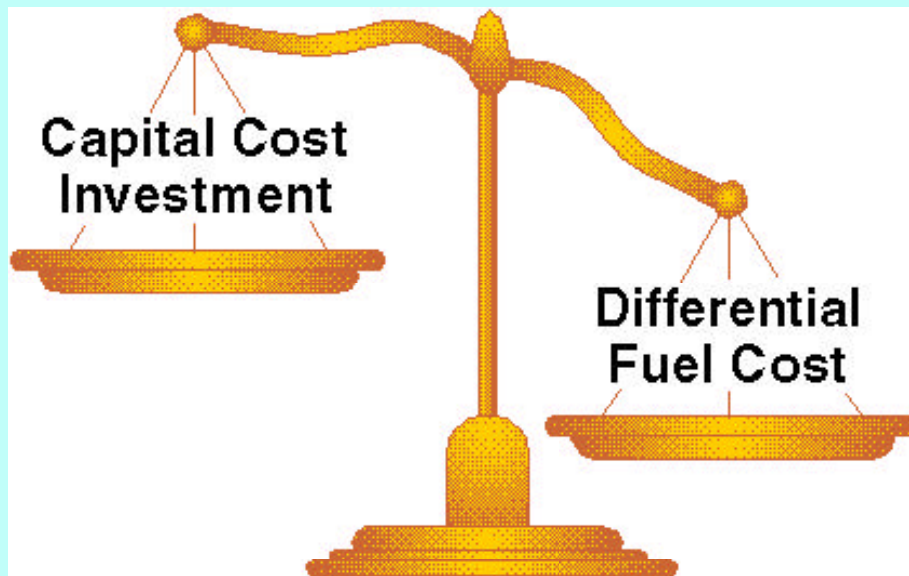
Capital Outweighs Fuel Cost Differential



- Low Natural Gas Prices Do Not Generate a High Resource Cost Differential
- Plentiful Natural Gas Resources with Ready Deliverability
- Natural Gas-Fired Simple Combustion Turbines or Combined Cycles Are Technologies of Choice

IGCC Decision Balance

Fuel Cost Differential Outweighs Capital



- **Increased fuel cost differential vs. natural gas**
- **Decreased capital costs**
- **Niche market opportunities**
 - Refinery waste utilization (El Dorado, STAR, Baytown)
 - Refinery waste/Pet Coke with high cost natural gas (Italian projects and Puertollano)
 - Cogeneration/Trigeneration (H₂ & steam)
 - Coproduction (Fuels & Chemicals)

IGCC Program Strategy

- **Operating experience with CCT demonstration projects to reduce technical and financial risks in commercialization**
- **Technology improvements**
 - Transport gasifier, improved air separation to produce oxygen, improved gas cleaning, improved gas separations, advanced materials and instrumentation
 - Utilize the Power Systems Development Facility (PSDF) to evaluate emerging technologies at an industrially-relevant scale of operation
- **Extend applications to cogeneration/trigeneration and coproduction**
- **Extend power generation capabilities through hybrid cycles using fuel cells and advanced combustion turbines**
- **Broaden the experience base with additional low cost resources, such as biomass, MSW, and industrial wastes**

IGCC Program Activities

■ Gasification Systems Technology

- Gasification
- Gas Cleaning/Conditioning
- Products By-Products Utilization
- Gas Separations

■ Systems Analyses/Product Integration

- IGCC/Co-production Pioneer Plant Feasibility
- Design Optimization/Vision 21 Concepts
- Technology Database & Market Strategy

IGCC Program

■ Gasification

- Transport Reactor
- Alternative Feedstock Evaluations
- Gasification Improvements:
Refractory and High Temperature
Measurement Instrumentation

■ Gas Cleaning/Conditioning

- Ultra-Clean Synthesis Gas for
Fuel Cells and Co-production
- Hot Gas Desulfurization for Power
- Novel and Advanced Sulfur
Sorbents
- Characterization and Control of
Alkali and HAPS/Trace Species

■ Gas Separations

- Hydrogen Separation
- Air Separation
- CO₂ Separation
and Recovery

■ Products/By-Products Utilization

- Fuel Cell/Turbine
Hybrid Integration
- Synthesis Gas Conversion
Co-production
- Slag/Ash Quality
Improvement
- Sulfur Recovery

IGCC Vision

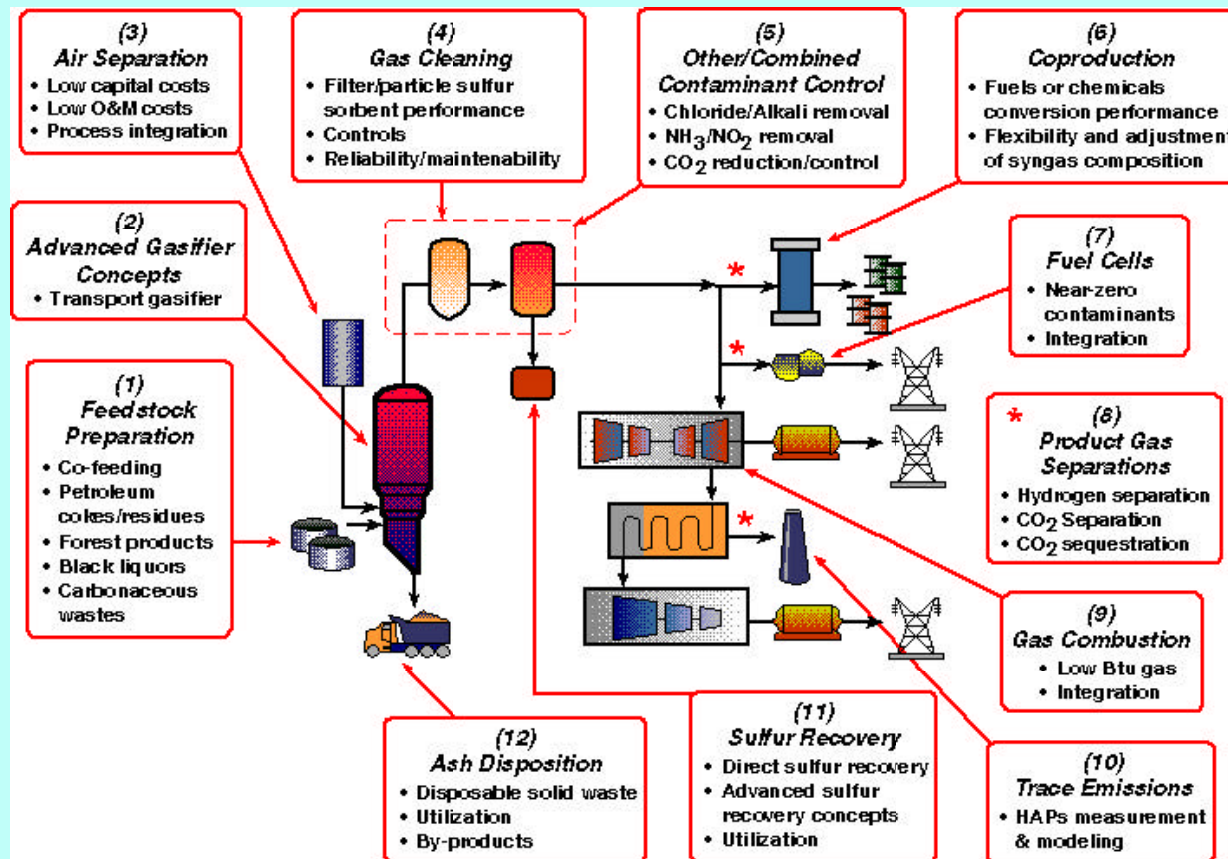
■ By 2015, gasification-based technologies will have:

- Gained global acceptance
- Penetrated world-wide power generation markets
- Achieved widespread use in the petroleum refining and pulp and paper industries,
- Attained, via coproduction, deployment in the fuels and chemicals markets

■ Gasification-based processes will be the technology of choice by:

- Being the low-cost leader
- Providing superior environmental performance
- With commercial guarantees, and
- With financing readily available

IGCC R&D Issues



Overall System

- Process simulation
- Instrumentation/control
- Capital cost/product costs evaluation
- Process optimization

IGCC Clean Coal Technology Demonstration Projects

Accomplishments: Operation of the Nation's first three commercial-scale coal gasification combined-cycle power plants, with each achieving 95% or greater sulfur removal, and 90% nitrogen oxide reductions:



■ Wabash River Coal Gasification Power Plant

- Awarded Power magazine's Powerplant of Year Award for 1996
- World's largest single-train IGCC power plant
- Demonstrated retrofitting of existing steam-cycle power plant
- Achieved 103% of rated capacity and 95% availability



■ Tampa Electric Company's IGCC Project

- Awarded Power magazine's Powerplant of Year Award for 1997
- Operated successfully with both coal and petroleum coke feedstocks
- Provides low-cost power to the host system and is the first-dispatch power generator for TECO



■ Piñon Pine IGCC Project

- World's largest advanced IGCC power plant using air-blown fluidized-bed and advanced gas turbine
- First IGCC operating plant to use hot-gas cleanup featuring a transport desulfurizer

Ion Transport Membranes (ITM-O₂)

■ Objective

- Develop ceramic membrane-based technology for low-cost production of oxygen

■ Participants

- Air Products/Texaco
- McDermott
- Northern Research & Engineering Corp. (NREC)
- Ceramtec
- Eltron Research

■ Cost

- Phase I = \$25 million (50% cost share)

■ Status

- In negotiation

